

Beneficial Use of Industrial Materials and Recycling in Wisconsin DOT Projects

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KEY PLAYERS

Wisconsin Department of Transportation (WisDOT)

The Wisconsin Department of Transportation (WisDOT) is recognized as a national leader in beneficially using fly ash and foundry sand in transportation improvement projects and in recycling asphalt and concrete pavements. WisDOT has worked closely with the Wisconsin DNR on recycling several industrial byproducts, working through the DNR's approval process for the use of industrial byproducts (see below for details). It has an active research program and evaluates recycled materials and industrial byproducts for use under standard engineering practices. WisDOT engineers evaluate new materials and new approaches for using them in smaller-scale projects, moving them to "business as usual" procedures once they are fully proven.

It is WisDOT policy to encourage the use of industrial byproducts and recycled or reclaimed materials when those materials deliver performance equivalent to that of traditional materials at a comparable or lower cost. Notably, WisDOT continues to re-write its Standard Specifications¹ as "performance-based specifications," facilitating the use of recycled materials to the maximum extent possible given that such use is consistent with standard engineering practices. Finally, as a national leader in this area, WisDOT provides outreach within its own organization and to contractors, major industry groups, other State departments of transportation and State environmental agencies by publishing documents and presenting at technical workshops.

Some quick facts and figures.....

- WisDOT recycles all of its old pavements: about 2 million tons of asphalt pavement and 1.6 million square yards of concrete pavement to date, using about 360,000 tons of RAP in new pavements each year.
- WisDOT estimates that it has used several hundred thousand cubic yards of foundry sand as fill material.
- WisDOT allows the use of up to 30% fly ash as a Portland cement replacement.

WisDOT has several specifications that specifically allow or call for the use of industrial materials, e.g.:

- WisDOT Standard Special Provision 208-020 "Fly Ash For Subgrade Stabilization Furnished"

- WisDOT Standard Special Provision 208-025 “Fly Ash Subgrade Stabilization”
- WisDOT Standard Special Provision 209-010 “Backfill Controlled Low Strength” allows for use of fly ash.

Wisconsin Department of Natural Resources (DNR)

The DNR has a streamlined, largely self-implementing *Beneficial Use of Industrial Byproducts Program* that encourages the safe, beneficial use of fly ash, bottom ash, paper mill sludge, and foundry sand and slag as an alternative to placing those materials in landfills. *Chapter NR 538 of Wisconsin Administrative Code* governs the beneficial use of industrial byproducts, establishing five categories of industrial byproducts according to chemical characteristics and providing twelve pre-approved beneficial uses based upon those categories. Industry estimates indicate that the beneficial use of industrial byproducts in Wisconsin is well above the national average, with approximately 72% of coal ash, 45% of foundry byproducts and 63% of paper mill sludge being beneficially used in Wisconsin in 2000.²

Wisconsin enacted legislation in 1985 to encourage the beneficial use of industrial byproducts. NR 538, in its original drafting, was a cooperative effort between the DNR and WisDOT. WisDOT considers that the regulatory language in NR 538’s statement of Purpose represented a breakthrough point, as it was key to experimentation with using a variety of industrial byproducts in Wisconsin by WisDOT.

The purpose of this chapter is to allow and encourage to the maximum extent possible, consistent with the protection of public health and the environment *and good engineering practices*, the beneficial use of industrial byproducts in a nuisance-free manner. The department encourages the beneficial use of industrial byproducts in order to preserve resources, conserve energy, and reduce or eliminate the need to dispose of industrial byproducts in landfills.

-Chapter NR 583.01, Wis. Adm. Code, January 2006 (emphasis added)

CASE STUDY #1: Use of Fly Ash in an Embankment by WisDOT

Location *STH 57, Dyckesville Bypass, Kewaunee County, Wisconsin (DOT ID 1480-08-72)*

Project Background *Part of a major 4-lane project connecting Green Bay to Sturgeon Bay WI.*

Embankment Complete 8/25/05. www.dot.state.wi.us/projects/d3/wis57/index.htm

1. Contact Information

WisDOT: *Ken Hanzel, (920) 492-5676, kenneth.hanzel@dot.state.wi.us*

Generator: *Wisconsin Public Service*

2. Material Used

- a. Specific type: *Fly Ash (Not C, most likely off-spec.)*
- b. Source: *Wisconsin Public Service Green Bay Plant*
- c. Amount used: *65,000 CY or about 84,500 tons*
- d. Amount of virgin material that the recycled material replaced: *65,000 CY*

3. How the material was used/Application

- a. Application: *Fly ash was used as fill in an embankment*
- b. Type of project: *WisDOT regular practice*
- c. Related standards and specs used:
DOT Standard Specifications (Section 207 – Embankment), DOT Special Provisions, Wisconsin DNR Environmental Specifications listed in NR 538
- d. Special technical considerations/adjustments³
The possible use of byproducts is included in the project environmental document 5+ years prior to construction. About 2+ years prior to construction, DOT solicits potential providers for project. About 1 ½ + years prior to construction, provider is selected and agreement is reached; cell is included in plan. Liner must meet NR 538.6 specifications.
- e. Performance issues/Environmental Monitoring
No concerns to date.

4. Savings and Benefits

- a. Economic benefits
Approximately \$110,000 savings to DOT for this cell.⁴ Site must be located near a generator or hauling cost for the provider could become too high. Clay liner material as per NR 538 must be found on the site or near (within a few miles) or clay liner cost to the DOT could be too high. Fills need to be large enough to economically place material, usually at bridge abutments or large fill areas where cells can hold a minimum of 25,000 CY.
- b. Landfill Space Savings: *65,000 CY*

5. Follow-up to assess recycled material performance or environmental impacts

Provider must monitor site as per NR 538.20

6. Photos or other documentation

See endnotes.

CASE STUDY #2: Use of Fly Ash to Stabilize Soils by WisDOT

Location *Fly ash stabilization had been used on five projects in southern Wisconsin by 2006. The first project was a three mile stretch of Wisconsin State Highway 32, a four-lane road.*

Project Background *These fly ash stabilization projects, part of a WisDOT initiative to use select materials to improve subgrades, often occurred as contract changes. On STH 32, the contractor replaced 20" of sand subbase with fly-ash stabilized existing subgrade.*

1. Contact Information

WisDOT: Bruce Pfister, (608) 246-7945, bruce.pfister@dot.state.wi.us

WI DNR: Bizhan Sheikholeslami, (262) 574-2143, bizhan.sheikholeslami@dnr.state.wi.us

Thomas Bennwitz, (608) 275-3211, thomas.bennwitz@dnr.state.wi.us

Consultant: Edgerton Construction

2. Material Used

- a. Specific type: *Class C Fly Ash*

3. How the material was used/Application

- a. How was recycled material used? *Class C fly ash was used to stabilize the soil subgrade, providing a stable platform for base placement and paving operations.*
- b. Type of project: *Wisconsin DOT regular practice*
- c. Related standards and specs used:
WisDOT Standardized Special Provisions 208-020 and 208-025
Wisconsin DNR Environmental Specifications listed in NR 538
- d. Special technical considerations/adjustments
The treatment is most effective in silt and clay soils, so a thorough examination of subgrade soils is important. Soils with significant cobbles are problematic. The application rate must be determined and included in the contract.
- e. Performance issues/Environmental Monitoring
WisDOT experience with fly ash stabilized subgrades has been positive. WisDOT has not experienced problems with frost heaves or localized subgrade failures.

4. Savings and Benefits

- a. Short or Long term performance benefits
Soil stabilization improves a weak subgrade, providing a stable platform for base placement and paving operations. Strength gains in the mixture are significant – often 4 to 8 times that of the untreated soil—and permanent. Secondary functions are to improve long-term pavement performance and to reduce pavement costs.
- b. Economic benefits
One project resulted in \$350,000 savings. Cost—currently about \$4.00 to \$4.50 per sq. yd.—is comparable or less than alternate construction methods.

5. Follow-up to assess recycled material performance or environmental impacts

WisDOT will continue to monitor and report on existing installations.

6. Photos or other documentation

See “WisDOT_Stabilizing Soils with Fly Ash_BPfister.ppt” for details and photos.

USEFUL LINKS

Chapter NR 538 of Wisconsin Administrative Code

www.legis.state.wi.us/rsb/code/nr/nr538.pdf

EPA's Resource Conservation Challenge

www.epa.gov/rcc

Wisconsin DNR Beneficial Use of Industrial Byproducts Program website

www.dnr.state.wi.us/org/aw/wm/solid/beneficial/

Wisconsin DOT Construction Standards Library

www.dot.state.wi.us/business/engrserv/construction-library.htm

¹ <http://www.dot.state.wi.us/business/engrserv/construction-library.htm>

² <http://www.dnr.state.wi.us/org/aw/wm/solid/beneficial/>

³ Provider responsible for material. Hauling specifications part of DOT contract. Contractor responsible to build and place material as per NR 538 and DOT specifications. DOT ensures all specifications are followed and met.

In this case fly ash was specified from WPS after solicitation of our sources and a selection process. Costs are not known when an agreement is reached because the project has not gone through the low bid process. In this case there was a benefit to the DOT. This benefit is not always realized.

Any issues or concerns with stockpiling or transportation addressed by DNR and DOT.

⁴ Cost for located approximately 20 miles from provider for placement of 65,000 CY:

Assume borrow @ \$3.25 / yard, borrow saving about \$211,000.

Note: Borrow estimated from other adjacent projects, no borrow required on this project.

Extra cost of liner, (\$3.54 for liner material – \$3.25 for borrow) x 25,360 CY of liner material = \$7350.

Placing material bid at \$1.15 / CY x 65,000 CY = \$74,750.

Cell Maintenance during construction = \$8000.

Extra engineering and testing costs = about \$10,000

Total cost to DOT, \$7350 + 74,750 + 8000 + 10,000 = \$100,100.

Borrow – Cell cost, \$211,000 – \$100,100 = about \$110,900.

Cost to WPS for hauling, bid \$4.20 / ton x 84,500 tons = \$354,900

When borrow is required for DOT projects, the price includes the material, hauling and placing per cubic yard at 1 price (in this case \$3.25). The DOT does not charge the provider for placement only hauling and there is no charge for the material. Therefore placing is specific to fly ash. There appears to be a net cost for using fly ash, but remember the provider is not charged any landfill (tipping) fee, only for trucking which would be a cost to haul to a landfill in any case. The DOT saving is in the cost of the material (free) and hauling.